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Management and Conservation Note

Ground Roost Resource Selection for Merriam's Wild Turkeys

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ABSTRACT Concealment cover is important for ground-roosting wild turkey (*Meleagris gallopavo*) poults immediately following hatch during the vulnerable, preflight stage. We compared concealment cover resources selected at ground roosts to those of nest sites and available resources for Merriam's turkeys (*Meleagris gallopavo merriami*) in the Black Hills of South Dakota, USA. Females with preflight poults selected ground roosts that were similar in structure to nest sites. Ground roosts and nests were greater in visual obstruction (unit odds ratios $\geq$1.19) than random sites. However, ground roosts were closer to meadow–forest edges than either nests or random sites (unit odds ratios $\leq$0.98). Structure at ground roosts may provide visual protection from predators, and management for shrub vegetation or woody debris along meadow–pine forest ecotones will provide cover for Merriam's turkey broods.

KEY WORDS Black Hills, ground roost, Merriam's, ponderosa pine, resource selection, wild turkey.

Assessment and knowledge of wild turkey (*Meleagris gallopavo*) demographics during the earliest portions of life are critical for accurate evaluation of overall population status. Survival of poults is a key factor in annual recruitment to wild turkey populations (Kurzejeski and Vangilder 1992, Hubbard et al. 1999, Rumble et al. 2003). Moreover, predation is greatest on poults too young to fly to arboreal roosts (Spears et al. 2007). Therefore, attaining quantitative assessments of critical habitat and environmental factors that may affect poult survival during the early life stages is essential for sound management (Roberts and Porter 1998, Spears et al. 2007).

After hatching, turkey poults are flightless for 1 to 2 weeks (Williams 1974). During this period, turkeys brood under the female on the ground at night. Concealment cover, such as vegetation, downed woody debris, and guard objects such as rocks and trees, hide poults and reduce the ability of predators to detect birds. In the Black Hills of South Dakota, USA, mammalian predators are the cause of most nest failures and presumably are also a key factor in preflight poult survival (Rumble et al. 2003, Spears et al. 2007, Lehman et al. 2008).

Compared with nest sites, habitat characteristics of ground roosts have been less rigorously evaluated. Eastern wild turkeys (*Meleagris gallopavo silvestris*) in Florida, USA, generally roost on the ground under a canopy of cypress (*Taxodium* spp.) or slash pine (*Pinus* spp.) in sparse understory cover (Barwick et al. 1970). In Wyoming, USA, Merriam's turkeys (*Meleagris gallopavo merriami*) selected northeast- or east-facing slopes for ground roosts and avoided riparian, wet meadow, and open grasslands (Hengel 1990). Rio Grande turkeys (*Meleagris gallopavo intermedia*) selected ground roost sites with greater visual obstruction, increased tree decay, and a higher percentage of grass, shrub, litter, and forb cover (Spears et al. 2007). Although descriptions of ground roosts (e.g., Barwick et al. 1970, Hengel 1990, Spears et al. 2007) and nest sites (Schemnitz et al. 1985, Lutz and Crawford 1987, Wakeling 1991, Rumble and Hodorff 1993, Lehman et al. 2008) are similar, we found no published research contrasting resource descriptions of these 2 important elements of wild turkey reproduction. We hypothesized that female turkeys with preflight poults would select ground roost sites that resembled nest sites to provide better concealment cover and enhance poult survival. Our objectives were to 1) characterize selected resources of ground roosts chosen by Merriam's turkey broods, and 2) compare vegetation and structural characteristics of ground roosts to nests at the microhabitat level. We provided resource selection information for nests in a previous publication (Lehman et al. 2008).

STUDY AREA

The study area (1,213 km^2) included Custer and Fall River counties in the southern part of the Black Hills physiographic region (Flint 1955), South Dakota, USA. The southern Black Hills have elevations ranging from 930 m to 1,627 m above mean sea level, with diverse topographies of rocky ridges, drainages, steep canyons, and mountain valleys (Kalvels 1982). The study area had a continental climate with a mean annual precipitation and an annual temperature of 44.02 cm and 7.78° C, respectively (National Climatic Data Center 2000). Land cover types were mostly ponderosa pine (*Pinus ponderosa*) forest (48%) and meadows (23%). Twenty-nine percent of the study area was burned by wildfires in 2000 and 2001. Rare stands of Rocky Mountain juniper (*Juniperus scopulorum*) and deciduous draws (<1%) occurred in the area. Western snowberry (*Symphoricarpos occidentalis*) and common juniper (*Juniperus communis*) shrubs were frequent in the understory, whereas serviceberry (*Amelanchier alnifolia*), bearberry (*Arctostaphylos uva-ursi*), and chokecherry (*Prunus virginiana*) occurred less frequently

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(Hoffman and Alexander 1987). Common native grasses included needle and thread (*Stipa comata*), western wheatgrass (*Pascopyrum smithii*), blue grama (*Bouteloua gracilis*), little bluestem (*Schizachyrium scoparium*), and prairie dropseed (*Sporobolus heterolepis*; Larson and Johnson 1999).

METHODS

We captured Merriam's turkey females in winter from 2001 to 2003 using cannon nets (Dill and Thornsberry 1950, Austin et al. 1972), rocket nets (Thompson and Delong 1967, Wunz 1984), and drop nets (Glazener et al. 1964). We recorded age of captured females as either adult ($\geq$1 yr) or yearling (<1 yr) based on the presence or absence of barring on the 9th and 10th primary feathers (Williams 1961). We fitted Merriam's females with 98-g backpack-mounted radiotransmitters equipped with activity, loafing, and mortality signals (Advanced Telemetry Systems, Isanti, MN).

We obtained locations of female turkeys systematically throughout nest initiation and incubation, as described in Lehman et al. (2008). After nests hatched, we systematically selected broods to identify ground roosts. We identified ground roosts by locating radiomarked females with preflight poults by direct observation aided by a handheld Yagi antenna in early morning or late evening. We mitigated disturbance to females and their broods by maintaining a distance $\geq$20 m between observers and the roost location. We recorded the nest and ground roost locations with a Global Positioning System. If we did not visually observe the exact site, we identified location of the roost by the depression left by the brood female and poult fecal droppings. We revisited these sites 1 day after the female and brood left to confirm the location and collect measurements.

We estimated macrohabitat resource availability from within the study area, which was delineated with a 100% minimum convex polygon of all female wild turkey locations for our random sampling design. We delineated the study area using the Home Range Extension (Rodgers and Carr 1998) in ArcView 3.3 (Environmental Systems Research Institute, Redlands, CA). We intersected this polygon with the Black Hills National Forest Service Resource Information System (RIS) Geographic Information System (GIS) coverage (2000 Black Hills National Forest Vegetation Database; United States Department of Agriculture Supervisor's Office, Custer, SD). We based vegetation descriptions of polygons in the RIS coverage on 5 sample plots systematically located in each polygon as established by the inventory protocol. We based vegetation descriptions on a hierarchical classification of vegetation types and vegetation structural stages (Buttery and Gillam 1983). Vegetation structural stages included meadows, shrubs and saplings, pole stands (2.54–22.9-cm dbh), and mature or saw-timber stands (>22.9-cm dbh) with overstory canopy cover categories in pole and mature or saw-timber forest of 0–40%, 41–70%, and >70%. Rare habitats that comprised <1% of the area included deciduous draws and shrubs. We delineated polygons of vegetation on private land within the area and assigned vegetation type and structural stages by comparing these polygons with classified polygons from adjacent United States Forest Service land using 1:24,000 aerial photographs and digital orthophotographs to aid our interpretation.

We used stratified random sampling to estimate microhabitat resource availability (Cochran 1977). Strata for random sampling were vegetation descriptions assigned to polygons of the GIS coverage. We randomly selected 15 polygons of each vegetation structural stage without replacement and selected one random point in each of these from a 30-m grid.

We characterized vegetation at random, ground roost, and nest sites along transects centered at the ground roost, nest, or random point, and we averaged vegetation for each variable. We estimated overstory canopy cover using a Geographic Resource Solutions (Arcata, CA) densitometer from 50 point measurements at 1-m intervals along a single transect following the contour (Stumpf 1993). When we located roosts, nests, or random sites on flat topography, we orientated transects in a random direction by turning the housing of a compass to obtain a bearing. We measured visual obstruction readings (VOR) of understory vegetation by placing a Robel pole with 2.54-cm increments at the ground roost or nest bowl and at a 1-m distance from each site in the 4 cardinal directions (n = 5; Robel et al. 1970, Benkobi et al. 2000). We measured VOR at 5-m intervals (n = 12) along a linear transect at random sites. We recorded VOR for all sites as the lowest visible increment on the pole viewed from 4 m away. We estimated VOR from the 4 cardinal directions at the ground roost or nest bowl; however, at the peripheral 1-m measurements, we estimated VOR from 3 cardinal directions minus the VOR measurement back across the roost or nest to avoid duplicating visual obstruction readings across the site. We also measured vertical height of live vegetation each time we recorded VOR measurements.

We estimated the percentage of canopy cover (Daubenmire 1959) for total herbaceous cover, grass, forbs, shrubs, pine slash, and plant species in a 0.1-m^2 quadrat at the ground roost or nest bowl and at 2-m intervals in the cardinal directions along 4 transects (n = 30). We measured understory canopy cover for random sites along one 30-m transect (n = 30). We measured tree characteristics in 3 plots with one centered at the ground roost, nest bowl, or random point and 2 plots 30 m on either side of points along the contour. When we located sites on flat topography, we orientated transects randomly using the method described above. We recorded all trees $\geq$15.24-cm diameter at breast height in a variable-radius plot using a 10-factor prism (Sharpe et al. 1976). We recorded data for trees <15.24-cm diameter at breast height in a 5.03-m fixed radius plot. We recorded aspect as the prevailing downhill direction from the site using a compass; we estimated slope along this same gradient with a clinometer (Suunto Co., Helsinki, Finland). We interpolated downed woody debris (t/ha) for forest area surrounding sites from a pictorial guide (Simmons 1982). We measured and truncated distance (m) to the nearest edge or ecotone (i.e., meadow–pine interface) at 100 m.

We also categorized ground roosts and nests by primary screening cover based on the percentage of understory canopy cover of vegetation or woody debris or the presence of guard objects. When the highest percentages of understory cover values were composed of shrubs, forbs, or grasses, we categorized primary screening cover as *vegetation*. When the highest percentages of understory cover were composed of pine slash, and downed woody debris values were >25 metric tons/ha, we categorized primary screening cover as *woody debris*. We categorized primary screening as *guard objects* when total understory vegetation cover measured <50%, and guard objects provided most of the visual obstruction.

In analyses comparing ground roosts to random sites, we adjusted for deviations from proportional sampling of random sites, and we weighted these data (Cochran 1977). We assigned each random site a weight = $P_i \times N_t/N_i$, where P_i was the proportion of the entire study area comprising a particular stratum (i = vegetation structural stage), N_t was the total number of random samples, and N_i was the number of random samples in a particular stratum (i). Ground roost sites and nest sites received a weight of 1.0.

We conducted logistic regression univariate tests (PROC LOGISTIC; SAS Institute, Cary, NC) to assess differences for continuous variables between ground roosts and nest sites, ground roosts and random sites, and nest and random sites. We used chi-square contingency tables (PROC FREQ; SAS Institute) to compare the categories of aspect for comparisons. We calculated unit odds ratios and 90% confidence intervals, and we set the significance level at α = 0.10 for all comparisons; we selected α = 0.10 because the 0.05 level can fail to identify variables known to be important (Hosmer and Lemeshow 2000). We also report means and standard errors of continuous variables for ground roost, nest, and random sites. We hypothesized that wild turkey ground roosts would have greater visual obstruction and percentages of grasses, forbs, and shrub cover when compared with random sites (Hengel 1990, Spears et al. 2007). We also hypothesized that ground roosts and nests would be similar in selected resource characteristics.

RESULTS

We measured 24 ground roosts and 137 nests from 80 female wild turkeys (70 ad, 10 yearlings) from 2001 to 2003. We measured ground roosts from females with preflight poults varying in age from 1 day to 17 days from 4 June to 12 August each year. We measured 170 stratified random sites.

Female turkeys with preflight poults used guard objects (rocks, stumps, and trees), vegetation, and woody debris as primary screening cover at 42%, 33%, and 25% of ground roosts, respectively. Ground roosts had similar amounts of grass and shrub cover and little forb cover (Table 1). Little bluestem was the predominant grass species ($\bar{x}$ = 10.66%, SE = 3.29), and poison ivy (*Toxicodendron rydbergii*) was the most common shrub cover ($\bar{x}$ = 7.56%, SE = 3.52) at ground roosts.

Ground roosts were more similar to nests than to random sites (Tables 1, 2). Unit odds ratios indicated ground roosts and nests had steeper slopes (odds ratios $\geq$1.11), greater woody debris (odds ratios $\geq$1.11), greater visual obstruction (odds ratios $\geq$1.19), and greater shrub cover (odds ratios $\geq$1.04) than random sites. Ground roosts and nests had less grass cover (odds ratios $\leq$0.99) than random sites. Ground roosts had less shrub cover and visual obstructions and greater grass cover than nests. We found more ground roosts than nests on south-facing exposures and more nests than roosts on north and west exposures (χ^2_2 = 6.98, P = 0.03; north and west exposures were pooled). Ground roosts did not differ from random points in aspect (χ^2_2 = 2.41, P = 0.30; north and west exposures were pooled). We found more random sites on south exposures than nests (χ^2_3 = 13.76, P < 0.01). Nest and random sites did not differ in distance to edge, and ground roosts were closer to meadow–forest ecotones than either nest or random sites (odds ratios $\leq$0.98; Table 2).

DISCUSSION

Merriam's turkey females with preflight poults selected resources for ground roosts that resembled nests in the form of high visual obstruction. Guard objects, vegetation, and woody debris provided visual protection of female turkeys roosting with preflight poults. Selection for greater visual obstruction was also reported by Spears et al. (2007) for Rio Grande turkeys and by Hengel (1990) for Merriam's turkeys. Woody debris in our study was provided mostly by ponderosa pine limbs, tree tops, and slash created by logging. Ground roosts of Rio Grande turkeys often included woody debris in the form of fallen trees and branches for concealment cover (Spears et al. 2007).

In Wyoming, Merriam's turkeys selected ground roost slopes that averaged 60% (Hengel 1990). Although the slope at ground roosts in our study was substantially <60%, female turkeys selected greater slopes for both nesting and ground roosting. Selection by Merriam's turkeys for nesting on steeper slopes has been previously noted and may be an adaptation for avoiding predators (Petersen and Richardson 1975, Schemnitz et al. 1985, Rumble and Hodorff 1993, Lehman et al. 2008). Steep slopes, such as cliff ledges or the slopes of rocky ravines, may provide barriers and make it difficult for terrestrial predators to traverse these areas. We postulate that the underlying mechanism for selection of characteristics for ground roosts reflects avoidance of predators similar to that of nests. Mammalian predation is an important source of nest loss, and poults are particularly vulnerable during the first 14 days after hatching (Lehman et al. 2001, 2008; Rumble et al. 2003; Spears et al. 2007).

Selection for greater visual obstruction at nest sites than ground roosts may be related to the greater susceptibility to predation during the long incubation period. For visual obstruction, guard objects provided primary screening cover

Table 1. Means and standard errors for continuous covariates and number in aspect categories for Merriam's turkey ground roosts ($n = 24$), nests ($n = 137$), and random sites ($n = 170$) for all structural stage categories combined in the Black Hills, South Dakota, USA, 2001–2003.

Variable	Ground roosts		Nests		Random sites	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Basal area (m^2/ha)	14.4	1.8	12.7	0.8	14.3	0.9
Large tree ($\geq$15.24) dbh (cm)	25.5	1.0	28.0	0.6	24.1	0.8
Slope (%)	27.9	3.0	22.4	1.3	9.2	0.5
Aspect categories						
N (316-45°)	5.0		41.0		36.0	
W (226-315°)	3.0		34.0		48.0	
S (136-225°)	8.0		18.0		48.0	
E (46-135°)	8.0		44.0		38.0	
Woody debris (t/ha)	17.3	2.3	19.1	1.3	7.8	0.5
Distance to edge (m)	28.2	4.9	54.2	3.3	60.3	2.9
Visual obstruction (cm)	18.7	2.4	29.4	1.3	5.9	0.4
Grass cover (%)	24.9	3.7	16.5	1.7	40.0	2.7
Forb cover (%)	6.3	1.3	5.8	0.6	10.	1.3
Shrub cover (%)	25.2	5.3	34.5	2.1	8.8	1.0

for ground roosts, whereas nests were primarily screened by shrubs in the southern Black Hills (Lehman et al. 2008). Proximity of ground roosts to habitat edges likely reflects the foraging requirements for Merriam's turkey poults found in meadows. Poults forage in meadows for invertebrates that are required for rapid growth and development (Scott and Boeker 1975, Rumble et al. 2003). Furthermore, Merriam's turkeys select for edges of meadows to forage near the forest escape cover (Scott and Boeker 1975, Rumble and Anderson 1993, Rumble and Anderson 1996). We observed broods foraging in meadows, and often, females would lead their broods up into the forest immediately before sunset to ground roost for the night. The proximity of quality brood foraging habitat before roosting may be a primary factor in selection of ground roost locations closer to meadow–forest ecotones when compared with nests.

We observed tree roosting as early as 10 days of age, but most broods did not tree roost until 14–17 days of age. Our observations suggested that females postponed tree roosting until the entire brood could fly into a tree roost. Even if only one poult could not sufficiently fly, the female would keep the entire brood on a ground roost overnight; these observations were consistent with those of Spears et al. (2007) for Rio Grande turkeys.

Management Implications

Management to maintain or increase shrub vegetation or woody debris along meadow–pine forest ecotones may benefit Merriam's turkey broods by providing cover for ground roosts. Meadows and open forests typically have greater shrub cover than closed canopied forests. We encourage managers to prescribe timber harvests that promote conditions suitable for deciduous shrub species, such as western snowberry, chokecherry, and poison ivy, to provide cover for ground roosting. Woody debris from logging may provide temporary cover until shrubs become established.

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Table 2. Univariate tests, unit odds ratios (UOR) and 90% confidence intervals (90% CI) from univariate logistic regressions comparing ground roosts versus nests, ground roosts versus random points, and nests versus random points for Merriam's turkeys in the Black Hills, South Dakota, USA, 2001–2003.

Covariate	Ground roosts vs. nests				Ground roosts vs. random points				Nests vs. random points			
	χ^2	*P* value	UOR[a]	90% CI	χ^2	*P* value	UOR[a]	90% CI	χ^2	*P* value	UOR[a]	90% CI
Basal area (m^2/ha)	0.20	0.66	0.99	0.94–1.04	0.11	0.75	0.99	0.95–1.03	0.51	0.47	1.01	0.99–1.03
Large tree ($\geq$15.24) dbh (cm)	2.21	0.14	0.96	0.91–1.01	0.83	0.36	1.02	0.98–1.07	16.85	<0.01	1.05	1.03–1.08
% slope	2.59	0.11	1.02	0.99–1.05	52.04	<0.01	1.17	1.11–1.24	83.33	<0.01	1.11	1.08–1.15
Woody debris (t/ha)	0.29	0.59	0.99	0.96–1.02	23.64	<0.01	1.12	1.07–1.18	71.33	<0.01	1.11	1.07–1.14
Distance to edge (m)	10.65	<0.01	0.98	0.96–0.99	15.00	<0.01	0.97	0.96–0.99	0.65	0.42	1.00	0.99–1.00
Visual obstruction (cm)	11.82	<0.01	0.94	0.91–0.98	41.46	<0.01	1.19	1.12–1.27	242.15	<0.01	1.29	1.22–1.37
% grass cover	3.36	0.07	1.02	1.00–1.04	3.76	0.05	0.99	0.97–1.00	41.40	<0.01	0.97	0.96–0.98
% forb cover	0.09	0.77	1.01	0.95–1.07	2.30	0.13	0.97	0.94–1.01	12.30	<0.01	0.97	0.95–0.99
% shrub cover	3.16	0.08	0.98	0.96–1.00	12.57	<0.01	1.04	1.02–1.06	96.43	<0.01	1.06	1.05–1.08

[a] UOR > 1 indicates a positive relationship, and UOR < 1 indicates a negative relationship with the response variable.

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